Materials Sciences

THE EFFECTS OF NICKEL AND CHROMIUM CONTENT ON THE MAGNETOELASTIC AND HYSTERESIS PROPERTIES OF HEAT-TREATED STEELS

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In this study, experiments have been performed to measure the axial and circumferential magnetic hysteresis of two ferromagnetic high speed steel thin ring samples with varying nickel and chromium content, which are to be designed for use as non-contact magnetic torque sensors. The first sample, O-1, contains 0.3% nickel and 0.5% chromium, while the second sample, S-7, contains 0.0% nickel and 3.5% chromium. The objective was to compare the magnetic hysteresis and torque load sensitivity (field signal due to applied torque load) for the differing nickel and chromium contents as well as to determine the changes after heat-treatment. The hysteresis characteristics of a particular ferromagnetic material help determine the utility and/or efficiency of that material for a desired application. Consequently, torque load testing and hysteresis measurements were performed prior and subsequent to the heat-treating of each sample. In both cases, the circumferential hysteresis loop remained relatively unchanged, which is beneficial for a torque sensor application, where a large retentivity and high coercive force are both needed in the circumferential direction to maintain the integrity of the magnetization of the sensory region in that direction. The axial hysteresis for the O-1 sample retained a nearly constant, low coercive force and retentivity throughout the heat-treating cycle, which seems to be directly related to only small changes in its torque load sensitivity, as predicted from our earlier published research (J. Appl. Phys., May 2000). On the other hand, the axial hysteresis of the S-7 showed great change over the heat-treatment cycle. Although the coercive force remained fairly constant, the retentivity greatly increased following the heat-treatment. The increase in retentivity directly affected the nature of the torque load sensitivity for the heat-treated S-7. The plot of field signal vs. applied torque load of the heat-treated S-7 does not demonstrate the linear nature of the O-1 and the untreated S-7 plots. The magnitude of the sensitivity for the S-7 also diminishes subsequent to the heat-treatment.